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Analytical and graphical methods for the solution of one problem of transport logistics

This article shows the way to solve a specific problem of transport logistics using the potential method. The first support plan is constructed by the method of the north-western corner. The article also shows a graphical method for solving the problem. The article shows the optimal method for solving the problem of transport logistics using the example of the real economy of the Kostanay region (Arkalyk).

Keywords: Logistics, transport task, potencial, northwest corner, count, bipartite count, value, volume.

Logistics transportation — a system for organizing the movement of goods, with the choice of the optimal route, reducing the time and costs money.

Cargo transportation takes over the entire range of organizational issues in the field of transport logistics related to the transportation and safety products [1].

Logistics — the science of the movement of goods, controlled by a material flow and information [2].

Transport logistics — all steps from planning to organization and control of cargo transportation from getting to the final place of delivery of the item and from the source to consumer [3].

transport logistics tasks consist of:

– choosing the type and mode of transport;

– planning of transport processes;

– ensuring the unity of the whole process;

– preparation of optimal transportation routes.

To determine the total cost of transportation (S), it is necessary to know:

1) Fuel consumption for 1 liter;

2) The salary of the driver;

3) Amortization.

In this paper, we solve the problem of logistics below these farms, Kostanay region, Arkalyk city. Name of farms, the volume of the harvest and transportation, and storage in the following table (Table 1, 2). It also indicated the distance between farms and granaries (Table 3). Fuel consumption depends on the distance and type (load) technology.

Table 1

Volumes of goods at the points of departure

Title grain farms	Square crop (sown) (ha)	Collected wheat (T)	Productivity per hectare (c)	Number of flights
Aiman A_1	800	400	5	17
Sharipa A_2	500	250	5	11
Lina A_3	100	50	5	2
Kakim A_4	208	100	5	4

Table 2

Capacity elevators (silos)

Elevators	Capacity (t)
I B_1	250
II B_2	250
III B_3	300

Table 3

Distance from the point of departure to a point on the matter

Distance (km) (there and back)	Fuel consumption (L)	The point of departure A_i and destination B_j	The cost of fuel for 1 flight (y_x 115) tg	Total transportation costs for 1 flight 1)+2)+3)
56	22,4	A_3 B_1	2587	$7191 \approx 72$
60	24	A_1B_1 and A_4B_3	2760	$7374 \approx 74$
62	24,8	A_4B_1 and A_3B_3	2842	$7456 \approx 75$
66	26,4	A_1B_2 and A_3B_2	3036	$7650 \approx 77$
68	27,2	A_2B_2	3128	$7742 \approx 77$
70	28	A_1B_3 and A_2B_3	3225	$7839 \approx 78$
72	28,8	A_2B_1	3312	$7926 \approx 79$
74	29,4	A_4B_2	3404	$8018 \approx 80$

$$(A) = \begin{cases} |A_1B_1| = 30\ km, \\ |A_1B_2| = 33\ km, \\ |A_1B_3| = 35\ km. \end{cases} \qquad (S) = \begin{cases} |A_2B_1| = 36\ km, \\ |A_2B_2| = 34\ km, \\ |A_2B_3| = 35\ km. \end{cases}$$

$$(L) = \begin{cases} |A_3B_1| = 28\ km, \\ |A_3B_2| = 33\ km, \\ |A_3B_3| = 32\ km. \end{cases} \qquad (K) = \begin{cases} |A_4B_1| = 28\ km, \\ |A_4B_2| = 37\ km, \\ |A_4B_3| = 30\ km. \end{cases}$$

Transportation cost:

$$C = \begin{pmatrix} 74 & 77 & 78 \\ 79 & 77 & 78 \\ 72 & 77 & 75 \\ 75 & 80 & 74 \end{pmatrix}.$$

Volume of cargo at points of departure.

For transportation of used Kamaz trailer with a load capacity of 12 + 12 = 24 m.

This kind of transport for 1 km consumes 0.4 liters of fuel.

The cost (price) of fuel (kerosene) per 1 liter 115 tenge.

Depreciation and driver's salary for one flight (round trip) is 4614 tenge.

There is fuel consumption table depending on the distance from the A_i to B_j to and from B_j to A_i (back and forth) and determination the cost of transportation for one flight (Table 4).

Table 4

The first reference transportation plan by building a north-west corner

Suppliers	Consumers (granary)			Stock
	$I_{(\beta_1)}\beta_1$		$III_{(\beta_3)}\beta_3$	
Aiman A_1 α_1	10,5 p. 74 250	6,5 p. 77 150	78	400
Sharipa A_2 α_2	79	4 p. 77 100	6,5 p. 78 150	250
Lina A_3 α_3	72	77	2 p. 78 50	50
Kakim A_4 α_4	75	80	4 p. 74 100	100
Needs	250	250	300	800

Total cost of transportation:

$$\sum_{i=1,j=1}^{4.3} c_{ij}.$$

$x_{ij} = 10,5\cdot 74+6,5\cdot 77+4\cdot 77+6,5\cdot 78+2\cdot 78+4\cdot 74 = 777+500,5+308+507+156+296 = 2544,5(254450\ tg).$

We verify the plan for optimality. To determine the true value of potential we have to decide the following uncertain system.

$$\begin{cases} \alpha_1+\beta_1=74; \\ \alpha_1+\beta_2=77; \\ \alpha_2+\beta_2=77; \\ \alpha_2+\beta_3=78; \\ \alpha_3+\beta_3=78; \\ \alpha_4+\beta_3=74. \end{cases}$$

$$\alpha_1=0; \quad \beta_1=74;$$

$$\alpha_2=0; \quad \beta_2=77;$$

$$\alpha_3=0; \quad \beta_3=78;$$

$$\alpha_4=-4.$$

Defining the potential indirect value.

$$c'_{13}=\alpha_1+\beta_3=78=78=c_{13} \quad +$$

$$c'_{21}=\alpha_2+\beta_1=74<79=c_{21} \quad +$$

$$c'_{31}=\alpha_3+\beta_1=74>72=c_{31} \quad -$$

$$c'_{32}=\alpha_3+\beta_2=77=77=c_{32} \quad +$$

$$c'_{41}=\alpha_4+\beta_1=-4+77=70<75=c_{41} \quad +$$

$$c'_{42}=\alpha_4+\beta_3=-4+77=73<80=c_{42} \quad +$$

This plan is not optimal, because the cell (A_3B_1) indirect value potential c'_{31} greater than the true value c_{31}. $(c'_{31}>c_{31})$

Building optimal plan transport method of potentials [1].

Building the cycle.

$x_{31}x_{33}x_{23}x_{22}x_{12}x_{11}x_{31}$

$+-+-+-+$

Defining element:

$x=min\{x_{33},x_{22},x_{11}\}=min\{50,100,250\}=50.$

Then,

$x'_{31}=x_{31}+x=0+50=50.$

$x'_{33}=x_{33}-x=50-50=0.$

$x'_{23}=x_{23}+x=150+50=200.$

$x'_{22}=x_{22}-x=100-50=50.$

$x'_{12}=x_{12}+x=150+50=200.$

$x'_{11}=x_{11}-x=250-50=200.$

The new transportation plan Table 5 is as follows:

Table 5

Transportation plan

Suppliers	Consumers (granary)			Stock
	I β_1	*II* β_2	*III* β_3	
Aiman A_1 α_1	8 p. 74 200	8,5 p. 77 200	78	400
Sharipa A_2 α_2	79	2 p. 77 50	2,5 p. 78 200	250
Lina A_3 α_3	2 p. 72	77	78	50
Kakim A_4 α_4	75	80	4 p. 74 100	100
Needs	250	250	300	800

Verify the plan for optimality.

$$\begin{cases} \alpha_1 + \beta_1 = 74; \\ \alpha_1 + \beta_2 = 77; \\ \alpha_2 + \beta_2 = 77; \\ \alpha_2 + \beta_3 = 78; \\ \alpha_3 + \beta_3 = 78; \\ \alpha_4 + \beta_3 = 74. \end{cases}$$

$$\alpha_1 = 0; \quad \beta_1 = 74;$$

$$\alpha_2 = 0; \quad \beta_2 = 77;$$

$$\alpha_3 = 0; \quad \beta_3 = 78;$$

$$\alpha_4 = -4.$$

We verify the plan for optimality and define the potential indirect value.

$$c'_{13} = \alpha_1 + \beta_3 = 78 = 78 = c_{13} \quad +$$

$$c'_{21} = \alpha_2 + \beta_1 = 74 < 79 = c_{21} \quad +$$

$$c'_{31} = \alpha_3 + \beta_1 = 74 > 72 = c_{31} \quad -$$

$$c'_{32} = \alpha_3 + \beta_2 = 77 = 77 = c_{32} \quad +$$

$$c'_{41} = \alpha_4 + \beta_1 = -4 + 77 = 70 < 75 = c_{41} \quad +$$

$$c'_{42} = \alpha_4 + \beta_3 = -4 + 77 = 73 < 80 = c_{42} \quad +$$

In all unoccupied cells indirect value potential greater than the true value, $c'_{ij} \leq c_{ij}$.
Total cost of transportation.

$$S = 8 \cdot 74 + 8,5 \cdot 77 + 2 \cdot 77 + 2,5 \cdot 78 + 2 \cdot 72 + 4 \cdot 74 = 592 + 654,5 + 154 + 195 + 144 + 296 = 2035,5(203550\ tg).$$

Potential method improved the original plan, and the total cost of transportation decreased by 254450-203550 = 50900 tg. Comment.

The volume of cargo at points of departure are A_i and capacity of elevators, we used to build Tables (1 and 2) distribution transportation. To determine the total cost of transportation have used the number of flights from A_i in B_j and transportation cost.

$$S = \sum_{i=1,j=1}^{3,4} c_{ij} \cdot k_{ij},$$

where k_{ij} — the number of flights from A_i в B_j (roundtrip); c_{ij} — cost per flight (roundtrip) Graphic illustration of this problem can be given with the help of graphs. Then the method of «bypassing Count» can be used to solve this problem. (Tarry algorithm). (Fig. 1-3).

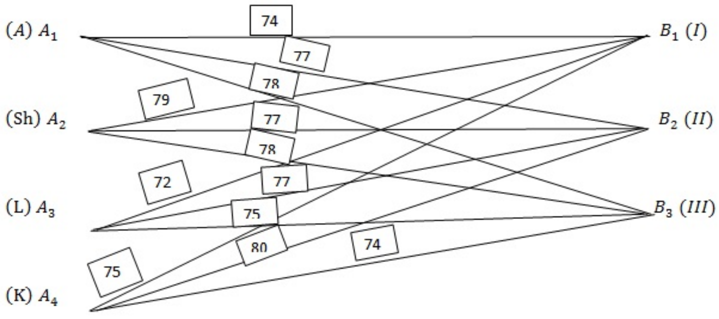

Figure 1. Count the total distribution of transportation, where A_1, A_2, A_3, A_4 - the points of departure (grain farms), B_1, B_2, B_3- Destinations (granary)

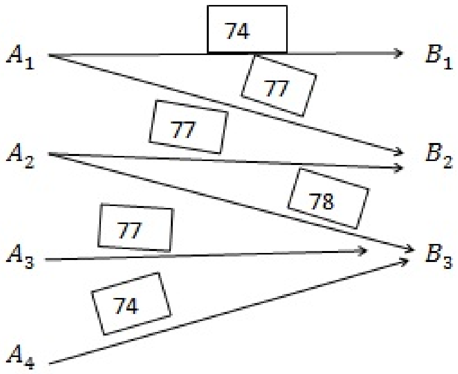

Figure 2. The graph corresponding to the first reference plane

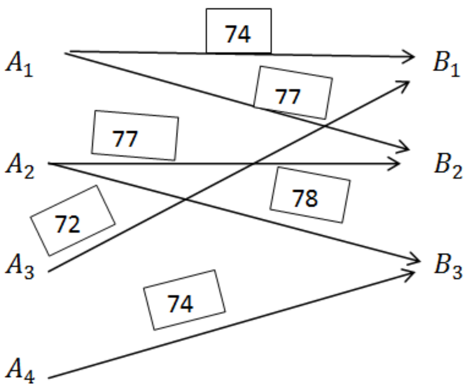

Figure 3. The graph corresponding to the second (optimal) distribution plan

These graphs are determined by the composition of graphs K_4 and K_3.

$$K_4 \cdot K_3 = G.$$

As a result, we obtain a bipartite graph with weights.
The vertices K_4 - A_1, A_2, A_3, A_4 — manufacturers.
The vertices — manufacturers.
The vertices K_3 - B_1, B_2, B_3 — consumers.
The vertices — consumers.
Count $G = K_4 \cdot K_3$ is also a weighted graph, where the weights are the elements of S.
Each arc A_iB_j directed graph G corresponds to the weight $c_ij \in C_0$

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Қ. Жетпісов, Н.Г. Карбенова

Транспорттық логистиканың бір проблемасын шешудің аналитикалық және графиктік әдістері

Мақалада нақты транспорттық логистика есебін потенциалдар әдісімен шешудің жолы көрсетілген. Алғашқы тірек жоспары солтүстік-батыс бұрышы әдісімен құрылған. Сонымен қатар есептік графиктердің көмегімен шешу әдісі де берілген. Авторлармен Қостанай облысы (Арқалық қ.) шаруа қожалығы мысалында көліктік логистика есебінің оңтайлы шешімі көрсетілген.

Кілт сөздер: логистика, көліктік тапсырма, потенциал, солтүстік-батыс бұрышы, санау, екі жақты санау, құндылық, көлем.

К. Жетписов, Н.Г. Карбенова

Аналитический и графический методы решения одной проблемы транспортной логистики

В статье показан способ решения конкретной задачи транспортной логистики методом потенциалов. Первый опорный план построен методом северо-западного угла. Кроме того, показан графический способ решения задачи. Авторами дан оптимальный метод решения задачи транспортной логистики на примере реального хозяйства Костанайской области (г. Аркалык).

Ключевые слова: логистика, транспортная задача, потенциальный, северо-западный угол, подсчет, двухсторонний счет, стоимость, объем.

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